(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number : **0 625 644 A1**

(12) EUROPEAN PATENT APPLICATION

(21) Application number : **94303584.0**

(22) Date of filing : **19.05.94**

(51) Int. Cl.[5] : **F16B 33/02**

(30) Priority : **20.05.93 US 63824**

(43) Date of publication of application :
23.11.94 Bulletin 94/47

(84) Designated Contracting States :
CH DE ES LI SE

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(54) Positive thread start fastener.

(57) A fastener 10, 12 includes an annular body 18, 20 having a screw thread 14, 16 spiraling therearound. The thread 14, 16 has a crest 14a, 1 6a and a pair of front and back flanks 14b,c, 16b,c extending laterally therefrom, with a start end 26a,b disposed adjacent to a front end 18a, 20a of the body. The start end 26a,b is flat from the back flank 14c, 16c to the front flank 14b, 16c and is inclined at an acute back angle relative to a helical axis 24a,b of the crest 14a, 16a for facing the start end 26a,b toward a back end 18b, 20b of the body.

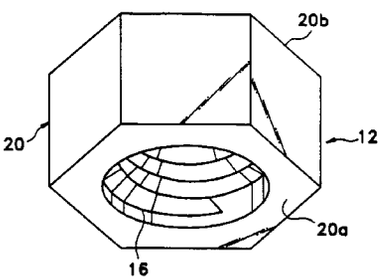

Fig. 1B

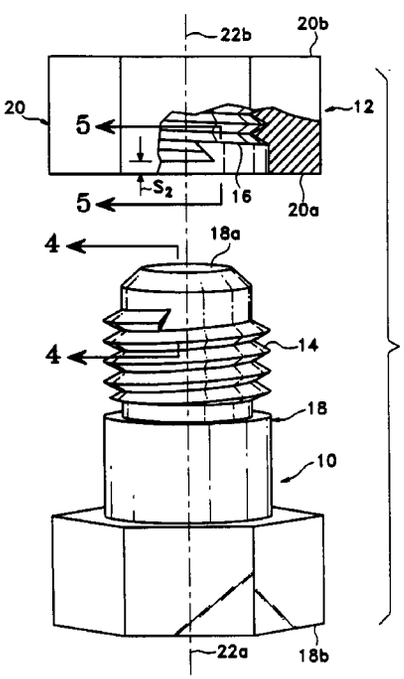

Fig. 1A

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The present invention relates generally to remote engagement of fastener components, and, more specifically, to a fastener having improved alignment and engagement features.

BACKGROUND OF THE INVENTION

In the environment of a nuclear reactor such as a boiling water reactor (BWR) for example, components within the reactor pressure vessel are located at a substantial distance below the top thereof and underwater when flooded during maintenance operations. Reactor components are typically assembled and disassembled by remote manipulation through the water to provide maximum shielding and distance from the radioactive environment adjacent the nuclear reactor core.

Threaded fasteners such as bolts and nuts are often used for assembling together components within the reactor. The engagement thereof is relatively difficult since limited access is typically provided in the crowded reactor pressure vessel and due to the flexibility of the remote handling tools which may extend up to about 25 meters below the operator and through the water.

A typical conventional bolt has a thread with a blunt or tapered start or leading edge for engaging with the respective leading edge or start end of the nut. The nut and bolt must be suitably initially axially aligned with each other with the respective threads being disposed closely adjacent to each other within a relatively small percentage of the thread pitch, for example about 5%, to ensure effective mating of the threads as they are rotated into engagement. Other configurations of the bolt front end are also conventionally known for more accurately initially joining together the bolt to the nut without damaging the threads due to misalignment or cross-threading thereof. However, conventional configurations vary in effectiveness and vary in their ability to be assembled using remote robotic or manipulation devices such as those required in the environment of the BWR for engagement at a substantial distance underwater.

Summary of the Invention

A fastener includes an annular body having a screw thread spiraling therearound. The thread has a crest and a pair of front and back flanks extending laterally therefrom, with a start end disposed adjacent to a front end of the body. The start end is flat from the back flank to the front flank and is inclined at an acute back angle relative to a helical axis of the crest for facing the start end toward a back end of the body.

Brief Description of the Drawings

The invention, in accordance with preferred and exemplary embodiments, together with further objects and advantages thereof, is more particularly described in the following detailed description taken in conjunction with the accompanying drawings in which:

Figure 1A is an exploded view of a pair of fasteners in the exemplary form of a bolt and nut having complementary screw threads in accordance with one embodiment of the present invention.

Figure 1B is a rotated view of the nut illustrated in Figure 1A.

Figure 2 is an elevational, partly sectional view of the bolt and nut illustrated in Figure 1 shown in initial starting engagement of respective start ends of the threads thereof.

Figure 3 is an enlarged elevational view of the front end of the bolt illustrated in Figure 2 showing the start end in more particularity.

Figure 4 is a partially sectional view of a portion of the bolt start end illustrated in Figure 1 and taken along line 4-4.

Figure 5 is a partially sectional view of a portion of the nut start end illustrated in Figure 1 and taken along line 5-5.

DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

Illustrated in Figures 1A-1B is a pair of complementary fasteners in the form of a bolt 10 and a nut 12 having respective screw threads 14, 16 configured in accordance with one embodiment of the present invention. The nut 12 is shown in two positions, one in partial cross-section closely adjacent to the bolt 10 (Figure 1A) and the other in rotated view for showing exemplary features of the screw thread 16 thereof (Figure 1 B).

The bolt 10 has an annular body 18 which is solid and generally cylindrical with a first or front end 18a and an opposite or back end 18b in the exemplary form of a hexagonal bolt head. Correspondingly, the nut 12 includes an annular body 20 which is tubular and similarly has a first or front end 20a and an opposite second or back end 20b The bolt 10 has an axial centerline axis 22a, and the nut 12 has an axial centerline axis 22b which are coaxial with each other upon assembly of the bolt 10 and the nut 12 with the respective front ends thereof 18a, 20a first facing each other.

The bolt screw thread 14 is an external thread conventionally spiraling around the body 18 coaxially with the body centerline axis 22a and projecting radially outwardly from the body 18, whereas the nut screw thread 16 is an internal thread conventionally spiraling around the body 20 in the inner surface thereof coaxially with the nut centerline axis 22b and projecting radially inwardly from the nut body 20.

Figure 2 illustrates the initial joining together of

the bolt 10 and the nut 12 and the initial engagement of the respective screw threads 14, 16 thereof.

Figure 3 illustrates in more particularity the configuration of the bolt 10 adjacent its front end 18a and the screw thread 14 thereon in accordance with one embodiment of the present invention. The screw thread itself has a crest 14a at its major diameter integrally joining a pair of front and back flanks 14b, 14c, respectively, in a conventional tooth-like sectional configuration with adjoining flanks defining a root 14d at a minor diameter. The configuration may be triangular as shown, or have other conventional shapes such as square or Acme for example. The crest 14a spirals around the bolt body 18 and around the centerline axis 22a and defines a crest longitudinal or helical axis 24a extending circumferentially or helically around the body 18 and obliquely to the body centerline axis 22a and substantially perpendicularly thereto as shown in the view illustrated in Figure 3. As shown, the front flank 14b faces forwardly toward the body front end 18a, with the back flank 14c facing rearwardly away therefrom and toward the body back end 18b (see Figure 1A).

In order to improve the ability to engage the bolt 10 and the nut 12 underwater using a remote manipulation device, for example, the bolt screw thread 14 in accordance with the present invention as illustrated in Figure 3 has a start end 26a disposed adjacent to the body front end 18a for first engaging a complementary start end 26b of the mating nut screw thread 16 as shown in Figure 2. The bolt start end 26a is illustrated in more particularity in Figures 3 and 4 and is preferably completely flat from the front flank 14b to the back flank 14c and is chamfered or inclined at an acute back angle B1 relative to the crest helical axis 24a for facing the bolt start end 26a away from the bolt front end 18a and toward the bolt back end 18b. As illustrated in Figures 3 and 4, for example, the bolt start end 26a projects radially away from the body 18 and the centerline axis 22a thereof and substantially perpendicularly thereto. Also in the preferred embodiment, the back angle B1 is about 45°, although in alternate embodiments it may have suitable values less than 90° to ensure engagement with the respective, and complementary, nut start end 26b.

Referring again to Figure 3, except for the start end 26a, the bolt screw thread 14 is otherwise conventional with the front and back flanks 14b, 14c forming a substantially symmetrical transverse thread configuration relative to the crest helical axis 24a. However, the chamfered start end 26a ends the symmetry of the screw thread 14 due to the back angle B_1 thereof. The bolt screw thread 14 along its front flank 14b at the start end 26a projects circumferentially farther than the back flank 14c at the start end 26a, with the back flank 14c thereat being hidden behind the front flank 14b at the start end 26a preventing direct line-of-sight with the engaging nut 12 and its complementary start end 26b.

In the preferred embodiment, the nut start end 26b as shown initially in Figure 2 is complementary in all regards with the bolt start end 26a, with the nut screw thread 16 being an internal thread whereas the bolt screw thread 14 is an external screw thread. Figure 5 illustrates in more particularity the nut screw thread 16 at its start end 26b. The nut screw thread similarly includes a crest 1 6a defining a crest helical axis 24b, and a pair of front and back flanks 16b, 16c extending laterally from the crest 16a. The crest 16a is at the minor diameter, whereas adjoining front and back flanks 16b, 16c define the root 16d disposed at the major diameter. The nut start end 26b is similarly flat from the front flank 16b to the back flank 16c and is also chamfered or inclined at an acute back angle B2 relative to the crest helical axis 24b for facing the start end 26b away from the nut front end 20a and toward the back end 20b thereof. The back angle B_2 of the nut start end 26b is preferably equal to the back angle B_1 of the bolt start end 26a so that the bolt and nut start ends 26a, 26b are parallel to each other upon engagement as illustrated in Figure 2 for drawing together the bolt 10 and the nut 12 upon threading together thereof.

The complementary start ends 26a, 26b as illustrated in Figure 2 in effect provide hooks which upon engagement thereof will pull together the mating threads 14, 16 into engagement as the parts are rotated relative to each other. The initial engagement of the cooperating start ends 26a, 26b is illustrated in Figure 2 in solid line, and is also illustrated in Figures 4 and 5 with the cooperating start ends being illustrated in phantom line. Since the respective start ends 26a, 26b are preferably completely flat in configuration they will be effective for pulling together the respective threads 14, 16 when they are axially positioned together anywhere within a tolerance of almost one full thread pitch (see the exemplary conventional thread pitch P illustrated in Figure 3). This is in contrast to conventional threads which typically require initial engagement of the respective threads thereof within an axial tolerance of only about 5% of the thread pitch.

Accordingly, the cooperating start ends 26a, 26b provide a positive thread start of the engaging threads 14, 16 for more quickly joining together the bolt 10 and the nut 12 without thread damage which is particularly useful where remote installation of the bolt 10 and the nut 12 is required such as in the boiling water reactor environment discussed above using remote manipulation devices at a considerable distance underwater.

In order to improve self-alignment of the bolt 10 into the nut 12, the bolt start end 26a as illustrated in Figure 3 is preferably spaced back from the bolt front end 18a at a predetermined spacing S_1 which therefore leaves an unthreaded piloting portion adjacent

the bolt front end 18a which may be used to guide or align the bolt into the nut 12. Similarly, the nut start end 26b as illustrated in Figure 5 may also be spaced back from the nut front end 20a at a predetermined spacing S_2 for improving initial alignment of the components prior to engagement of the respective start ends 26a, 26b.

Referring again to Figure 3, it will be noted that since the start end 26a is inclined backwardly or rearwardly toward an adjacent spiral of the thread 14, conventional machining of the start end 26a is not practical since a path for the machine cutter and for chip runout is not available. Accordingly, the start end 26a is preferably machined using conventional electrical discharge machining which now makes practical the formation of the start end 26a since the removed metal is consumed during the process. Electrical discharge machining is also used to form the start end 26b in the nut 12 for the same reason. Other processes that consume material such as electrochemical machining (ECM) may also be used.

While there have been described herein what are considered to be preferred and exemplary embodiments of the present invention, other modifications of the invention shall be apparent to those skilled in the art from the teachings herein, and it is, therefore, desired to be secured in the appended claims all such modifications.

Claims

1. A fastener 10, 12 comprising:
   an annular body 18, 20 having front and back opposite ends 18a,b, 20a,b and an axial centerline axis 22a,b extending therethrough;
   a screw thread 14, 16 spiraling around said body 18, 20 and having a crest 14a, 16a joining a pair of front and back flanks 14b,c, 16b,c in a generally tooth-like sectional configuration, said crest 14a, 16a defining a helical axis 24a,b extending helically around said body 18, 20; and
   said screw thread 14, 16 having a start end 26a,b disposed adjacent to said body front end 18a, 20a, and being flat from said front flank 14b, 16b to said back flank 14c, 16c, and being inclined at an acute back angle B_1, B_2 relative to said crest helical axis 24a,b for facing said start end 26a,b toward said back end 18b, 20b.

2. A fastener according to claim 1 wherein said start end 26a,b projects radially away from said body 18, 20 and perpendicularly thereto.

3. A fastener according to claim 1 wherein said back angle B_1, B_2 is about 45°.

4. A fastener according to claim 1 wherein said screw thread 14 is an external thread projecting radially outwardly from said body 18.

5. A fastener according to claim 4 wherein said start end 26a is spaced from said front end 18a.

6. A fastener according to claim 1 wherein said body 20 is tubular and said screw thread 16 is an internal thread projecting radially inwardly therefrom.

7. A fastener according to claim 6 wherein said start end 26b is spaced from said front end 20a.

8. A fastener according to claim 1 in the form of a bolt 10 in combination with an additional one of said fasteners in the form of a complementary nut 12, with said bolt and nut start ends 26a,b having substantially equal back angles B_1, B_2 so that said bolt and nut start ends 26a,b are parallel to each other upon engagement for drawing together said bolt 10 and said nut 12 upon threading together thereof.

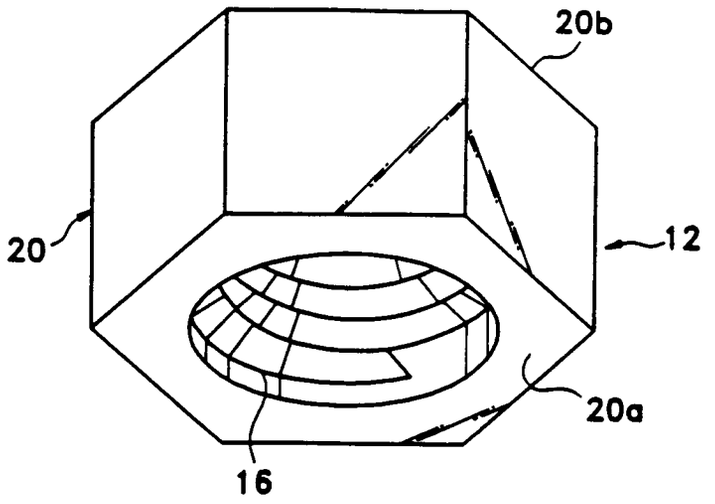

Fig. 1B

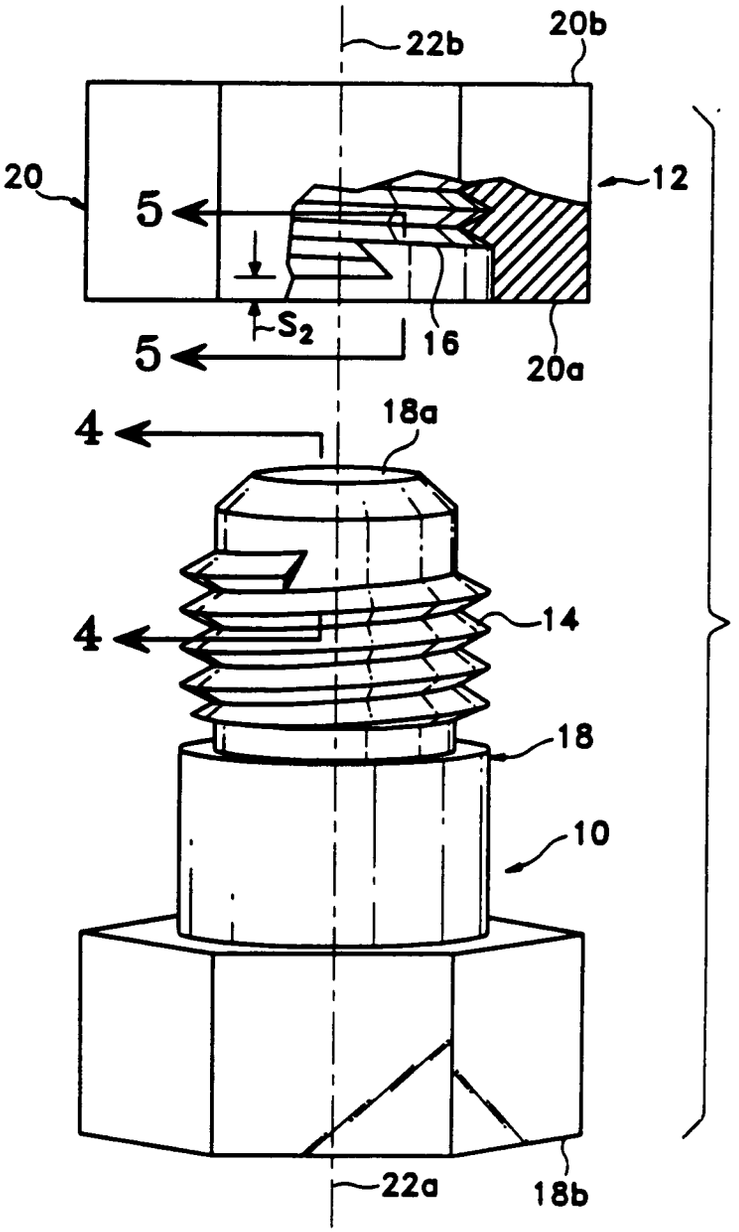

Fig. 1A

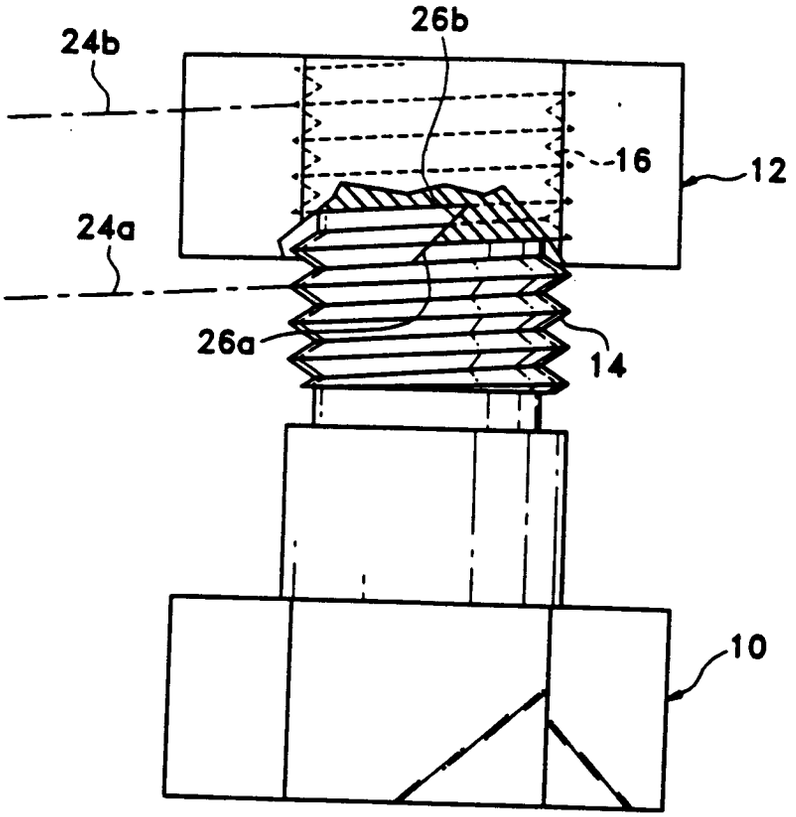
24b
26b
16
12
24a
26a
14
10

Fig. 2

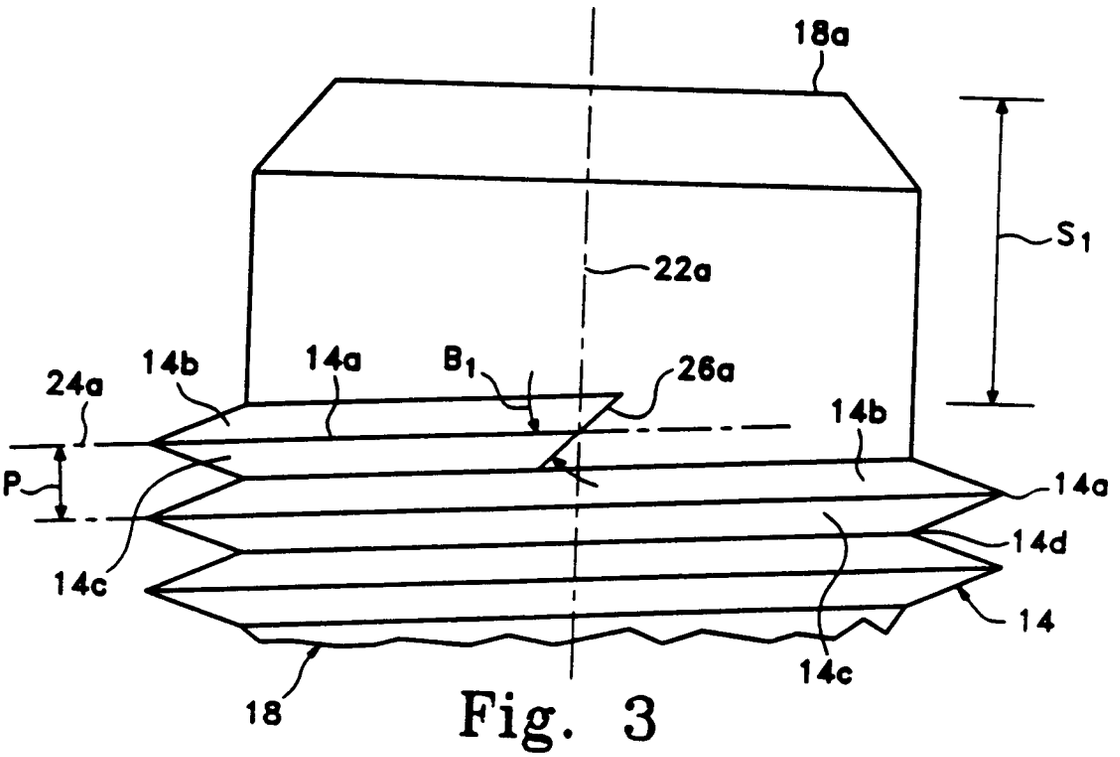
18a
S_1
22a
24a
14b
14a
B_1
26a
14b
P
14a
14d
14c
14
14c
18

Fig. 3

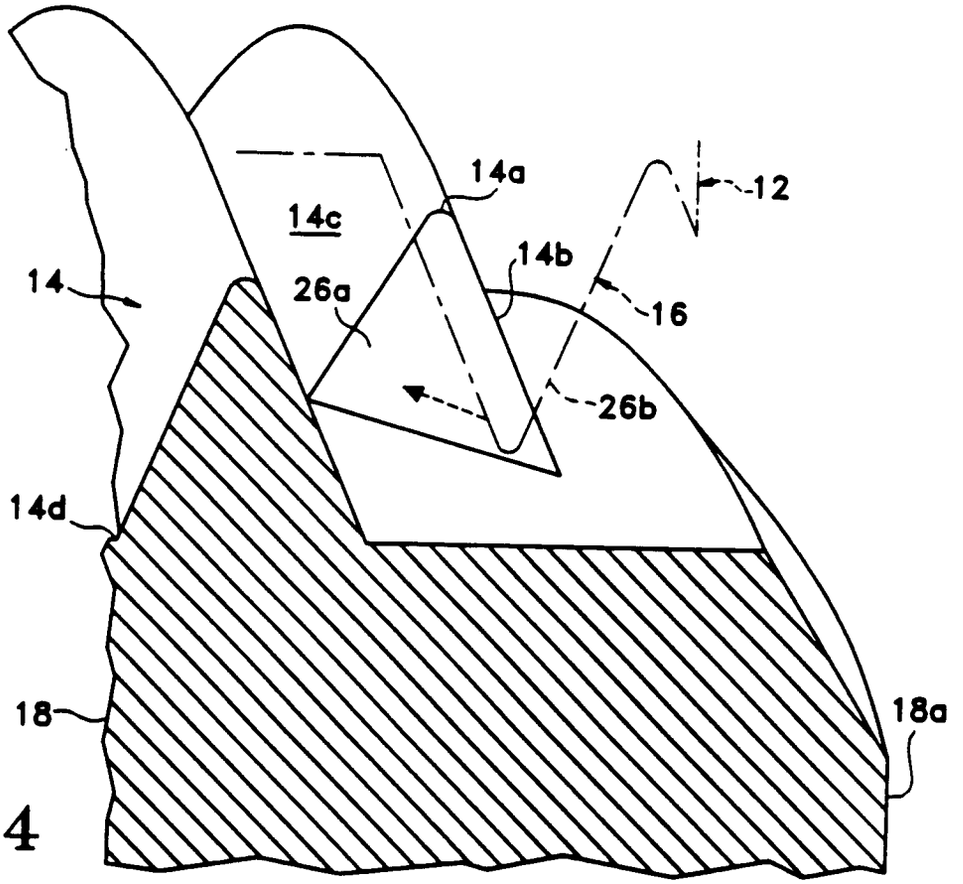
14a
12
14c
14b
14
26a
16
26b
14d
18
18a

Fig. 4

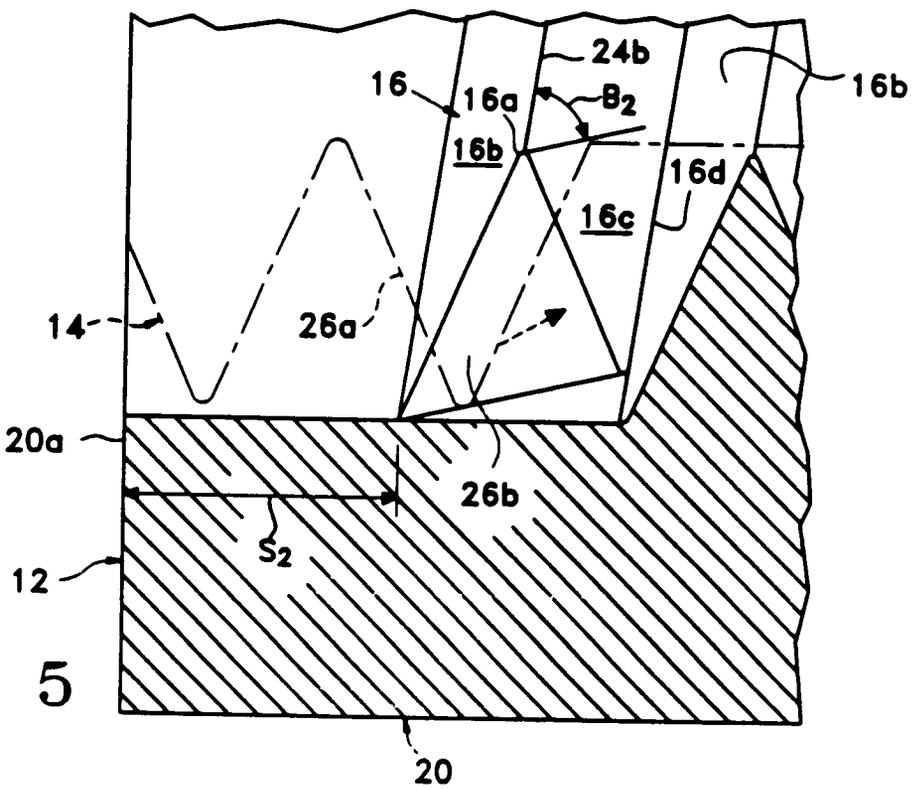
24b
16
16a
B_2
16b
16b
16d
16c
14
26a
20a
26b
S_2
12
20

Fig. 5

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 94 30 3584

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
X	DE-C-73 597 (JOHN F. BRAUN) * the whole document * ---	1	F16B33/02
A	DE-A-28 24 491 (LEISMANN) * the whole document * -----	5-7	

TECHNICAL FIELDS SEARCHED (Int.Cl.5)

F16B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	15 July 1994	Areso y Salinas, J

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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